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twist we get $\frac{4}{10}$, another twist $\frac{6}{16}$, etc. Some of our cones, then, fall into the phyllotaxis of opposite leaves the same as though the stem were more or less twisted. The single cone of the European larch which indicated the fraction $\frac{6}{15}$ (a fraction requiring a division of numerator and denominator by three to reduce it to its lowest terms) falls under decussate whorls of three for its simplest fraction.

I leave any further consideration of this matter showing the relations of the fractions to each other, etc., to those who have a greater skill in mathematics than myself. My examples indicate that we may look for some curious series of fractions by diligently examining the phyllotaxis of a great number of plants of many different species.

It would be interesting to know whether there are any cones which fall into series beginning with decussate whorls of four or more scales.

ON THE DISTRIBUTION OF CALIFORNIAN MOTHS.*

BY A. S. PACKARD, JR.

THE Phalænidæ (Geometrids) of California (including Oregon and Nevada) seem to be composed of four elements: (1) of species of genera exclusively American (North and South). Such are *Chœrodes*, *Sicya*, *Hesperumia*, *Tetracis*, *Azelina*, *Gorytodes* and *Metanema*. Certain species of these, with several of *Tephrosia* (a genus largely found in the New World) are the most characteristic of the Pacific slope of the United States.

(2) The species next most characteristic belong to the following genera: —*Halia*, *Tephrina*, *Selidosema* and *Heterolocha*. Species of these groups occur in Europe, but especially (all except *Halia* which has a species (*H. novaria*) living in northern Europe) in southern Europe, around the Mediterranean Sea, western Asia, and Asia Minor; while species of Heterolocha occur in Abyssinia and South America (Quito).

(3) The next group comprises a few arctic or circumpolar species of *Coremia*, *Cidaria* and *Larentia*, or of cosmopolite genera

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* Extracted from a communication presented to the Boston Society of Natural History, May 7, 1873.

such as *Hypsipetes*, *Cidara*, *Coremia*, *Eupithecia*, *Scotosia*, *Acidalia* and *Boarmia.*

(4) There are four species common to both the Pacific and Atlantic states, viz., *Larentia cumatilis*, *Camptogramma gemmata*, *Tephrosia Canadaria* and *Azelina Hübneraria.*

In the brief introductory remarks to the first part of this Catalogue (these Proceedings vol. xiii, 381) we briefly alluded to the fact that some Californian Lepidoptera repeat certain features peculiar to the fauna of Europe. I find that there are but two forms strikingly European among the Phalænidæ, viz., *Numeria Californiaria* Pack. (wrongly described by me as *Ellopia Californiaria* xiii, p. 384) which is very near the European *Numeria pulveraria*, and quite different from the Atlantic states *N. obfirmaria*, and the genus *Chesias* which does not, so far as yet known, occur in the Atlantic region.*

But if we find a very few species which recall the European fauna, there are on the other hand many peculiar European genera which do not occur in the Pacific region. In other groups of Lepidoptera there are some species that recall European types ; such, especially, are *Papilio Zolicaon* Boisd., representing the European *P. Machaon*; and the genus *Parnassius*, which does not occur in the Atlantic region.

Going out of the Phalænidæ, we find a few European types of Bombycidæ which occur in California and are not found in the Atlantic states, such as the genera *Epicallia* and *Callarctia.*

On the other hand we find in California no such development of the genus *Lithosia* as in Europe, no species of *Zygæna*, no *Psychidæ* (except *Phryganidia*, an aberrant form) ; no such development of *Hepialus*, while *Xyleutes robiniæ*, as in the Atlantic states, represents the European *Cossus ligniperda;* moreover the various forms of *Lasiocampa* and other allied genera are far less numerous if not (*L. Carpinifolia* Boisd. is, according to Grote, a species of Gastropacha) quite wanting in the Pacific region.

We miss again in the Pacific states any species of *Telea* or *Tropæa*, forms linking the Atlantic or northeastern American entomological fauna with that of northeastern Asia (*Telea* being represented by the closely allied *Anthærea* and *Tropæa Luna*

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*I also referred to a supposed species of *Rumia.* On further examination I find that this and the Maine species are types of a genus, different though allied to *Rumia,* and accordingly in the present paper call it *Hesperumia.*

being represented by *T. Selene* Leach). California has evidently not borrowed her insect fauna from northern China or Japan.*

In the Neuroptera we have strong European features, the genus *Rhaphidia*† occurring in the Pacific states, and not in the Atlantic, while *Boreas Californicus* is more like the European *B. hyemalis* than our two Atlantic species.

The crustacean fauna of northeastern America, with Limulus as its most remarkable feature, repeats that of eastern Asia; but on the other hand Dr. Hagen states that the European genus Astacus occurs in California, while Cambarus is only found east of the Rocky mountains.

Mr. F. W. Putnam informs me that of one hundred and seventy-three genera of fishes given by Günther as inhabiting the seas about Japan, only about thirty-six are represented on the northwestern coast of America, and of these thirty-six the majority are also found in the Atlantic, while about eighty others of the Japanese genera are also represented on the southeastern coast of North America and in the West Indian seas, of which a number are found on the western coast of Central America as well. He also tells me that the fresh water fishes of northern Asia, when compared with those of other regions, more nearly resemble those of the northeastern parts of North America, though a number of the genera are also common to both North America and Europe. By the same authority I am informed that there is a striking resemblance between the reptiles and batrachians of northeastern Asia and northeastern America.

My attention has been drawn to a consideration of these features in the geographical distribution of animals by a perusal of the able and suggestive essay by Prof. Gray on the distribution of California plants, in his address at the Dubuque meeting (Aug., 1872) of the American Association for the Advancement of Sci-

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*Dr. Boisduval, who was the first to publish a lepidopterous fauna of California enumerates the following species of Lepidoptera as being common to California and Europe:— *Vanessa Atalanta*, *V. cardui*, *V. Antiopa*, *Chelonia caja* and *C. Dahurica*, *Arctia* [Phragmatobia] *fuliginosa*, *Gonoptera libatrix*, *Phlogophora metriculosa*, *Amphipyra pyramidea*, *Agrotis exclamationis*, *A. annexa*, *A. saucia*, *A. fumosa*, *A. ravida*, *Cucullia asteris*, *C. lucipara*, *Plastenis subtusa* Fabr., *Noctua triangulum*, *N. plecta*, *Hadena pisi*, *H. protea*, *Monogona Hormos*, *Plusia festucæ*, *P. questionis*, *P. ni*.

These are scarcely more distinctive of Europe than of America, some of them being common to the subarctic regions of the two continents, and others may yet prove to be distinct from the European species.

†Rhaphidia has as yet only been found in Europe, northern Asia, and western North America (MacLachlan).

ence, and of Mr. Lesquereux' able papers in Hayden's Geological Reports on the Territories, 1872. The main features in the geographical distribution of land animals are apparently the same with those of plants. Prof. Gray shows that "almost every characteristic form in the vegetation of the Atlantic States is wanting in California, and the characteristic plants and trees of California are wanting here" (*i. e.*, in the Atlantic States). We may on the whole say of the Californian Lepidoptera, at least, as Dr. Gray remarks of the plants, that they are "as different from [those] of the eastern Asiatic region (Japan, China and Mandchuria) as they are from those of Atlantic North America. Their near relatives, when they have any in other lands, are mostly southward, on the Mexican plateau. . . . The same may be said of the [insects] of the intervening great plains, except that northward and in the subsaline [insects*] there are some close alliances with the [insects] of the steppes of Siberia. And along the crests of high mountain ranges the arctic-alpine [insect-fauna] has sent southward more or less numerous representatives through the whole length of the country" (p. 10). He then refers to the "astonishing similarity" of the flora of the Atlantic United States with that of northeastern Asia. Our actual knowledge of the insect species of northeastern Asia is most vague compared with the exact knowledge of the botanist, and the comparison we have drawn relates only to generic types.

It is evident that the notion of continental bridges in quaternary times, connecting for example Asia and California, is quite unnecessary, since there are, so far as is yet known, no forms characteristic of Asia in the Californian fauna, and the grand difficulty is to account for the presence of a certain resemblance to

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*Dr. Leconte has noticed the similarity of our saline-plains beetles, containing so many species of Tenebrionidæ, to the fauna of the deserts and steppes of Asia. (Proc. Amer. Assoc. Adv. Sci., 1851. Albany meeting, 252.) He also states that "the only manner in which the insect fauna of California approaches that of Europe, is in the great abundance of apterous Tenebrionidæ. But in this respect it does not differ from a large part of South America; and by the very form of these Tenebrionidæ, which bear no resemblance at all to those of Europe, the greater relation of the Californian fauna to that of the rest of America is clearly proved." Andrew Murray (on the Geographical Relations of the chief Coleopterous Faunæ, p. 36, 1871) also refers to this fact; the genus *Elodes* in California replacing the genus *Blaps*. He adds: "other Heteromerous forms, reminding us of Mediterranean and Asiatic species, occur in California, and the whole of the northwest of America has a greater preponderance of the microtypal stirps than perhaps occurs east of the Rocky Mountains." I should add that Mr. Murray in explaining the term *microtypal*, states that "the fauna and flora of our own land [Great Britain] may be taken as its type and standard."

the European fauna in that of California. Here I think Dr. Gray has been the first to indicate a solution of the problem. Our knowledge of American fossil tertiary insects is at present almost *nil;* we must, then, in the absence of any evidence to the contrary, follow the conclusions of Gray with the later confirmation of Heer and Lesquereux.

The ancestors of the Californian *Parnassius*, *Rhaphidia* and other European forms, may have inhabited the Arctic tertiary continent, of which Greenland and Spitzbergen are the remains, and their descendants forced southward have probably lost their foothold in the Atlantic region and survived in California and Europe, like the Sequoia in California. Something more than similarity of climate is needed to account for the similarity of generic forms; hence community of origin, with high antiquity and a southward migration of forms not of tropical origin, are the factors needed to work out the problem. That something of this sort has taken place in marine animals we know to be the fact. Certain forms now supposed to be extinct on the coast of New England and Scandinavia, such as *Yoldia arctica* Gray (*Nucula Portlandica* Hitchcock), are still living in the seas of Greenland and Spitzbergen. The quaternary fauna of Maine indicates a much more purely arctic assemblage than is at present to be found. This is also the case with the Scandinavian quaternary fauna, according to the researches of Prof. M. Sars. As we have before shown, the circumpolar marine fauna runs down along the coast of northeastern America and of Europe, and the forms common to the two shores have not come one from the other. Europe has not perhaps borrowed in quaternary times from America, but both have been peopled from a purely circumpolar fauna. If there has been any borrowing it has been on the part of Europe, since the fossil musk ox of France and central Europe is said to be identical with the musk ox of arctic America. So also on the coast of northeastern Asia and Alaska are circumpolar forms, which have evidently followed the flow of the arctic currents down each coast. The forms which are identical or representative on these two coasts are forms derived from the circumpolar fauna; so the forms which are so strikingly similar in northern Japan to those on the coast of New England are, if we mistake not, also derived from the northward. I believe it to be a matter of fact that the Atlantic States species of insects which are common to the two countries, are, if not of circumpolar, at least of subarctic or boreal origin. From these facts we are led to accept the conclusions of Lesquereux and Gray that co-specific or congeneric forms occurring in California and Europe and Asia, are the remnants of a southward migration from polar tertiary lands during tertiary and even perhaps cretaceous times; and in proportion to the high antiquity of the migrations there have been changes and extinctions causing the present anomalies in the distribution of organized beings which are now so difficult to account for on any other hypothesis.

For this reason it is not improbable that those species of insects which are more or less cosmopolite (and independently so of human agency) are the most ancient, just as some forms taxonomically the most remote are remnants of earlier geological periods. For example, the curious anomalies in the geographical distribution of *Limulus*, the genus only occurring on the eastern coasts of Asia and North America, accord with its isolation from other crustacea. Geological extinction has gone hand in hand with geographical isolation. It was a common form in Europe in the jurassic period, and in the next lower (permian) period but one (the triassic intervening) we find other Merostomata and a few Trilobites.

We make these speculations hoping that much light will be thrown upon the subject by studies on the rich tertiary insect beds of the west, and of the fossil insects in the arctic tertiary and cretaceous formations. Until then we must regard all foundations for these hypotheses as laid by the fossil botanist.

ON THE STATUS OF ARISTOTLE IN SYSTEMATIC ZOOLOGY.

BY THEODORE GILL, M.D., PH. D.

SUCH extravagant claims have been urged in favor of the recognition of Aristotle as an exponent of classificatory science, and as a model meet to be followed by the naturalists of the rising generation, that it may be timely to inquire into the merits of such claims, and whether they are really justified by his works. In doing so we must, of course, in justice to the ancient author, exclude from con-